COMMUNITY COAL UTILIZATION IN THE NORTHWEST TERRITORIES

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NORTHWEST TERRITORIES

NWT ED Comm

Report prepared for the Department of Economic Development and Tourism
Government of the Northwest Territories

Report prepared by Arctech Services, Inuvik, NWT

April 1978

-Overview

The vast quantities of coal in the Northwest Territories are a valuable resource that can be utilized for local resident benefit. At present there is no community or commercial coal utilization and only a few hunters and trappers pick up some coal when convenient. However, with the pressures of a conserver society ethic and increasing prices for heating oil, the possibilities of community coal utilization requires consideration and evaluation.

Coal is found throughout the northern sedimentary basins in the same areas where there is petroleum exploration along the Mackenzie Valley, across the Arctic Coast, and on the High Arctic Islands. Many of the coal occurences are shown in Figure 1. None of the coal deposits have been fully evaluated but, based on their nature and extent, there could be as much coal in the Northwest Territories as the 120 billion tons that have been found in the rest of Canada (27).

Some of the exposed coal seams have provided a fuel source to local residents for centuries. Others have been worked on a semi-commercial basis near Aklavik, Fort Norman, Paulatuk, and Pond Inlet. Most of the coal is a medium quality lignite with some higher quality bituminous coals found in the eastern sections of the High Arctic Islands. In recent years, with the ready availability of economical heating oil throughout the Northwest Territories, there has been no need to operate any of the coal mines. However, as the price of heating oil has doubled in the past few years and is expected to double again shortly, there is a new economic incentive to consider local coal deposits for economical home heating. There is also an incentive to create local resident business and employment opportunities.

A request for an evaluation of community coal utilization was made at the January 1978 session of the NWT Legislative Assembly by John Steen, member for the Western Arctic (13). Mr. Steen moved that "the administration conduct a study on coal deposits in the Northwest Territories and prepare a report to be brought before this House in May of this year". The motion was passed unanimously. The Mackenzie Great Bear member, Peter Fraser, requested that the coal deposits in his area be investigated. Inuvik member, Tom Butters, asked that a comparison be made on the cost of coal and heating oil from the Norman Wells refinery. Yellowknife North member, Dave Nickerson, wanted to know if it made economic sense for a small

mine to be operated in places like Paulatuk. Hay River member, Don Stewart, was interested in the possibilities for coal driven electric plants as being more economical than the present diesel plants in many communities.

This review of community coal utilization in the Northwest Territories outlines the possibilities and action that might be taken to open up small mining projects serving nearby communities. No attempt is made to examine large scale coal mining projects for thermal electric generation or coal export.

Figure 1 Location of Coal Occurrences In Northern Canada

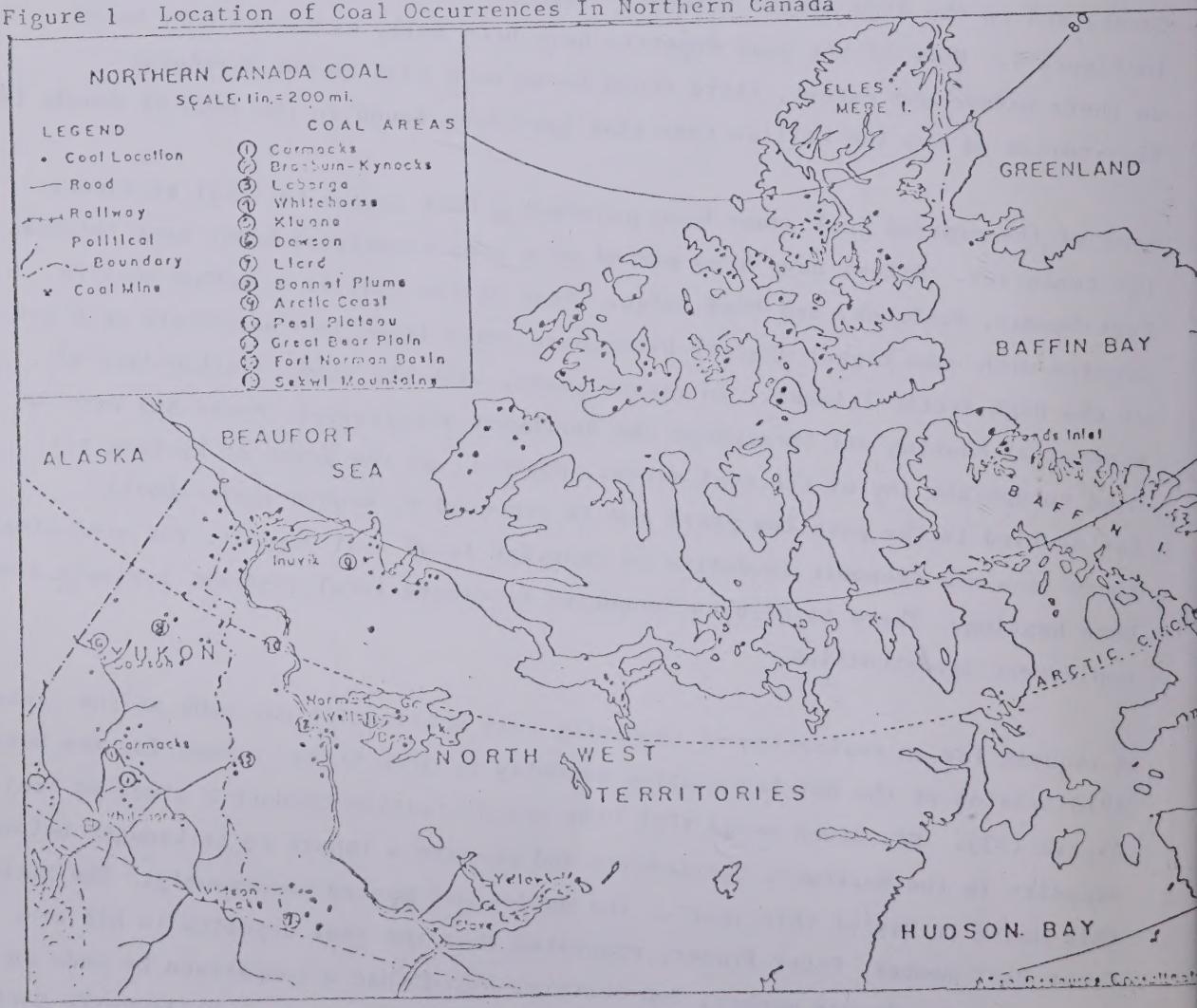


Figure 3

Representative Coal Quality

Sample	1.	2.	3.	4.	5.
Fixed carbon, %dry	53.8	24.8	35.3	48.5	68.5
Volatile matter, %dry	37.7	22.6	27.2	30.9	18.5
Ash, % of total wt	8.5	4.6	0.5	3.7	7.1
Gross heat content btu/lb	12240	5410	7780	10020	13690
Water, % of total wt	--	48	32	17	6

Samples: 1. Willow River area, west of Aklavik
2. Etacho Point, Scented Grass Hills, Great Bear Lake
3. Fort Norman area, Mackenzie River banks
4. Liard area, Liard River banks
5. McIntyre Porcupine Smokey River Mine, Alberta for comparison

Coal Bearing Regions

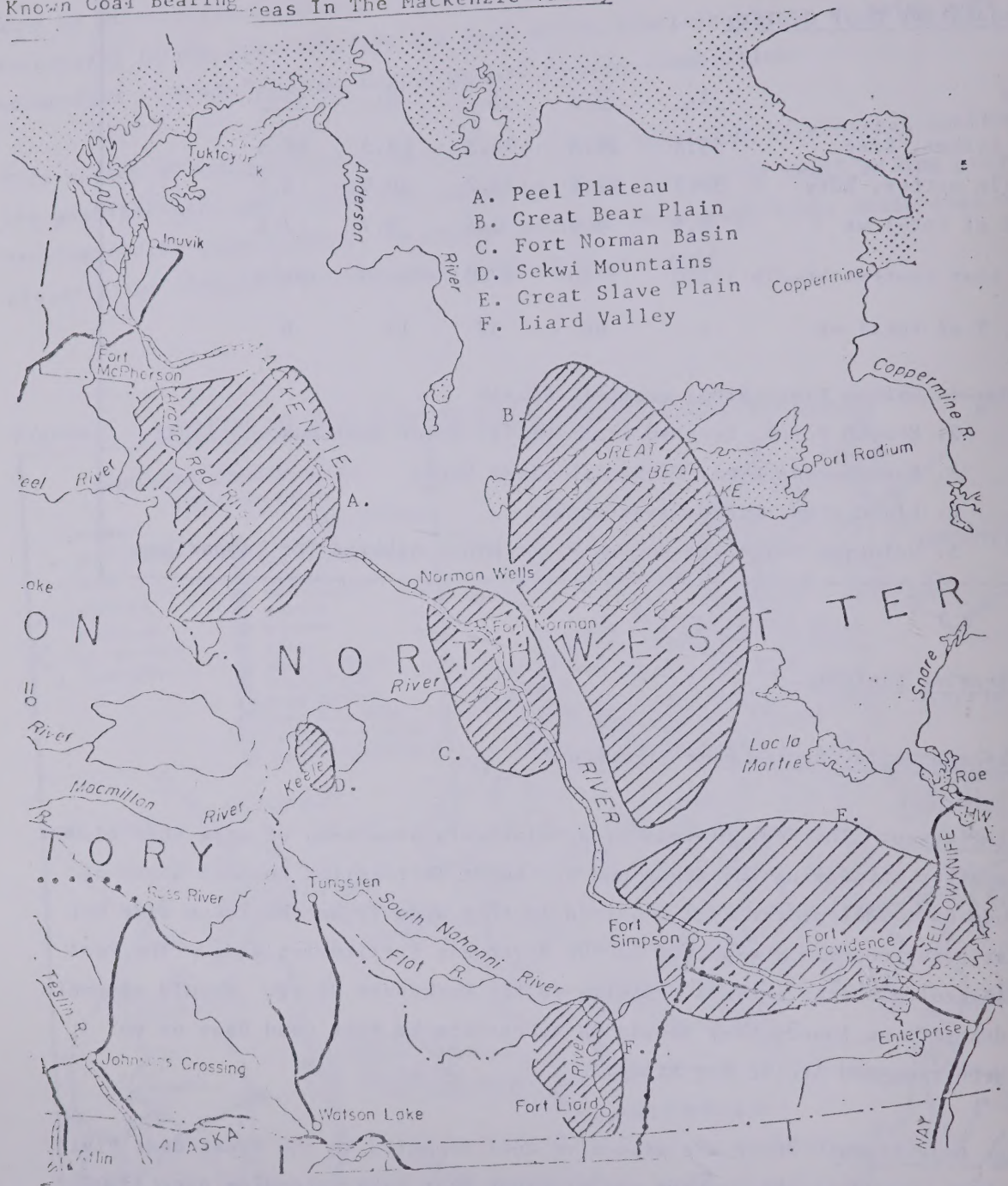
I-Mackenzie Valley Region (see Figure 4)

A-Peel Plateau: The Peel Plateau is a relatively even area of more than 12,000 square miles straddling the Yukon and Northwest Territories borders north of latitude 65°. All of the coal reported in this area is on the Yukon side but similar occurrences are expected on the Northwest Territories side. The Peel Plateau geologic area extends easterly to the Mackenzie River. Should mineable coal deposits be found, they should be accessible to Fort Good Hope or to Fort McPherson and Arctic Red River.

B-Great Bear Plain: There are extensive coal deposits in the Great Bear Plain area which straddles the western end of Great Bear Lake extending over 33,000 square miles. In the Scented Grass Hills area there are four lignitic coal seams along the west shore of Douglas Bay with thicknesses in order from top to bottom of 12 feet, 13.5 feet, 10 feet, and 18.5 feet(5). Nearby at Etacho Point there is a 13 foot seam in a cliff at the foot of the hills which rise to 1600 feet above Great Bear Lake (30). The Great Bear Plain deposits are

Figure 4

Known Coal Bearing Areas In The Mackenzie Valley



accessible to Fort Franklin. The mines at the eastern end of Great Bear Lake are investigating the use of the Douglas Bay coal in their mining operations.

C-Fort Norman Basin: The Fort Norman coal basin is a 7,000 square mile area extending along the Mackenzie River at Fort Norman. Most of the coal seams in the area are less than 10 feet thick but some have been measured up to 20 feet (20). For 18 miles along the East Fork of the Little Bear River there are lignite seams 8 to 10 feet thick that have been mined by Fort Norman residents (3). There are also good coal occurrences at Old Fort Point upstream from Fort Norman along the Mackenzie River. Mackenzie River steamers picked up coal here for use on the boats and for transport down the Mackenzie and along the Arctic Coast.

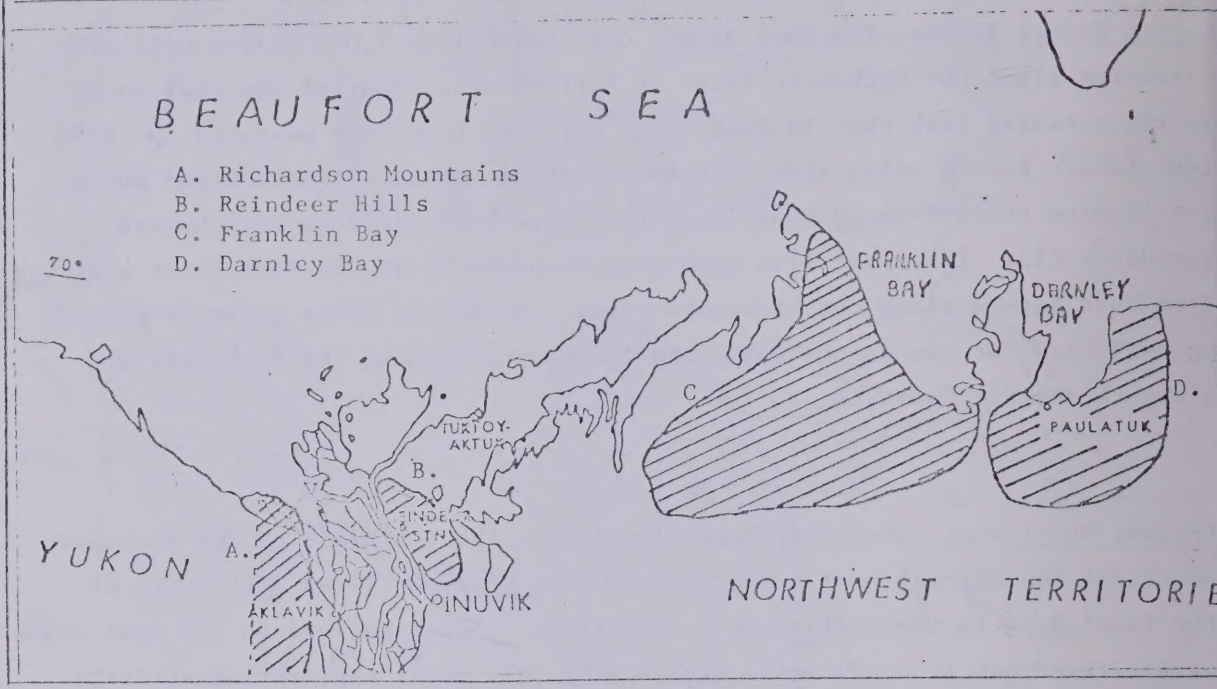
D-Sekwi Mountains: The Sekwi Mountain area in the foothills of the Mackenzie Mountains has several coal seams up to 5 feet thick outlined just south of the Canol Road in the Godlin Lakes area (20). Investigations on the coal seams were carried out in conjunction with nearby base metal exploration activity. With the expected opening of the Canol Road between the Yukon Border and Norman Wells, this coal bearing area would be accessible to the Mackenzie River.

E-Great Slave Plain: Exploratory drilling for oil in the Great Slave Plain between Fort Simpson and Fort Providence has encountered thin coal seams. These occurences are not economic but they do indicate the possibilities of economic deposits being found in the area.

F-Liard Valley: A few coal seams up to 20 inches thick are located along the Liard River in the southwest corner of the Northwest Territories. This coal is of low quality and is not utilized locally (5 & 21). The coal basin is a 200 square mile area in the foothills of the Mackenzie Mountains. Should commercial deposits of coal be found, the opening of the Liard Highway should make them accessible to Fort Liard and to Fort Simpson.

Figure 5

Known Coal Bearing Areas In The Arctic Coastal Plain



A-Richardson Mountains: There are several coal occurrences in the Richardson Mountain area which extends from the Mackenzie Delta westward along the Yukon Coast to the British Mountains. Only a small part of the area is within the Northwest Territories.

In the lower canyons of the Willow River to the west of Aklavik there are several coal seams. A 5 foot seam was mined in this area by Aklavik people prior to 1939 (3 & 20). There is a large coal occurrence along the Moose Channel close to the Yukon Border with two vertical seams of bituminous coal. A mine operated on the largest seam at Coal Mine Lake and delivered coal to Aklavik for several years until about 1960. More recently a 23 foot coal seam was reported nearby at Aklak Creek (23).

B-Reindeer Hills: There are several small coal occurrences along the Caribou Hills to the north of Inuvik but there have been no commercial findings (5). Oil drilling in the Parsons Lake area has found large seams at 5,000+ feet indicating that there could be commercial deposits in the area.

C-Franklin Bay: There are lignite coal deposits for 15 miles along the Horton River mouth area of Franklin Bay with seams up to 4 feet thick. Several of the seams appear to have been burning for centuries and are known locally as the Smoking Hills. Similar deposits are found to the south in the Langton Bay and Horton River areas (30). None of these coal deposits has been mined commercially.

D-Darnley Bay: There are lignite occurrences in the valley walls for several miles along the Hornaday River to the south of Darnley Bay. Accessible seams are located in the walls of the Rummy and George Creeks near their common junction with the Hornaday River. The "old mine" of the Paulatuk Mission operated here with underground and strip mining from 1936 to 1941 (3).

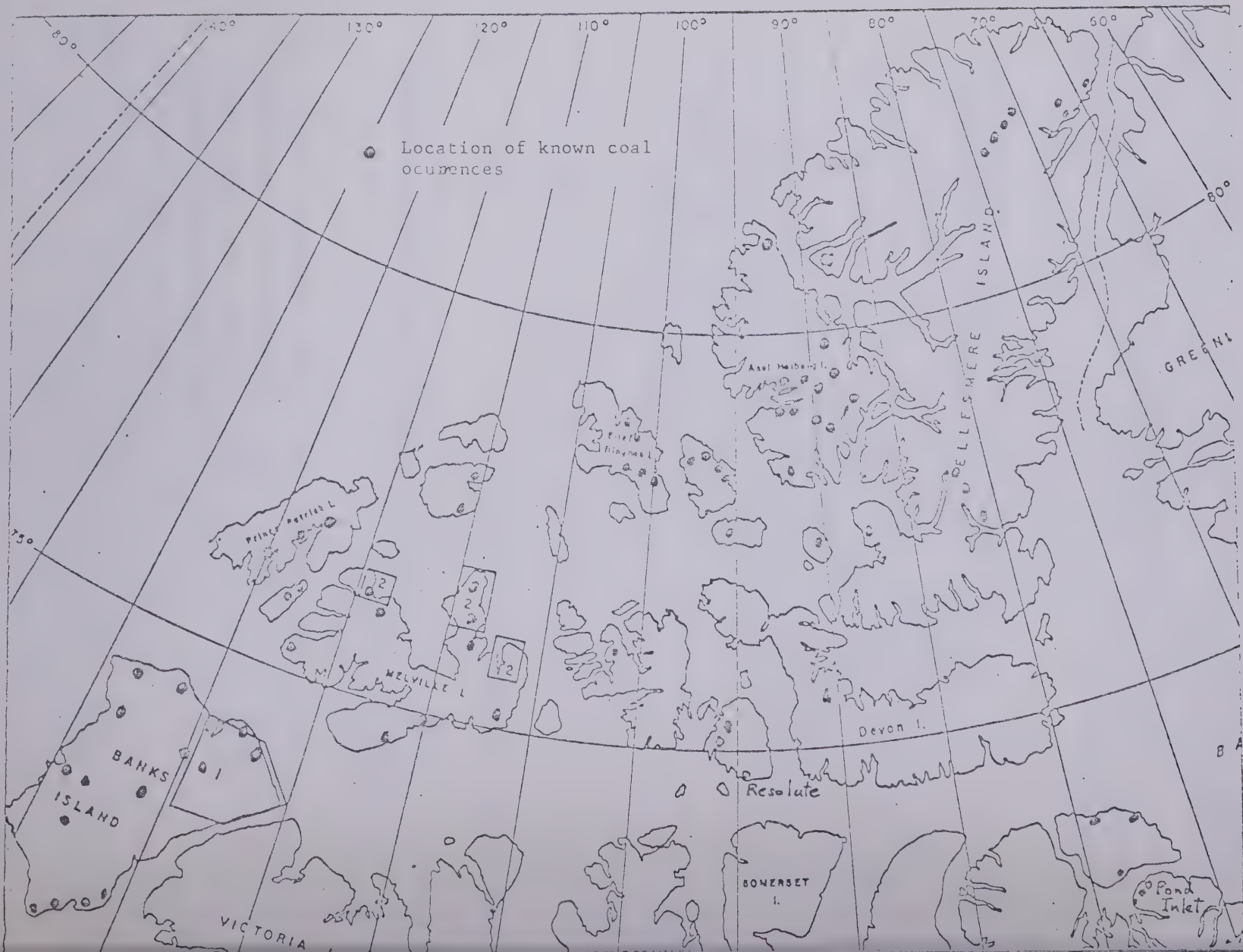
There is a good lignite seam along the Darnely Bay sea cliffs to the Northeast of the Hornaday River Delta. The "new mine" for Paulatuk operated here from 1941 to 1955. Along the east shore of Darnley Bay there are two coal seams, 15 and 40 foot thick, that are interbedded with shale and sandstone (30). A lignite exposure a few miles south of Pearce Point has occasionally been mined for local use (3).

High Arctic Islands Region (see Figure 6)

Although there are extensive coal deposits reported throughout most of the High Arctic Islands, only the occurrences located relatively close to communities are included in this section.

A-Banks Island: There are several thin coal seams on the north shore of Banks Island between Castle Bay and Cape McClure. One of the seams ranges between 10 and 15 feet thick (29). In the vicinity of Alexander Milne Point on the southwest coast of Banks Island there are several exposures of low grade coal. These deposits were utilized by families wintering at Jesse and DeSalis Bays and by Minto Inlet people on Victoria Island (33). There is a 3 foot lignite seam inland about 50 miles northeast of Sachs Harbour (19 & 30).

Figure 6 Known Coal Occurences In The High Arctic Islands



-Cornwallis Island: At the head of Intrepid Bay on Cornwallis Island there are least 12 coal seams ranging in thickness from a few inches to 5 feet. There ank is bituminous and they are interbedded with sand and clay (29). Other oal occurrences have been noted at Rookery Creek on Cornwallis Island (19). his coal is a good quality bituminous but is not found in commercial uantities.

-Baffin Island: At Tuluken, about 18 miles northwest of Pond Inlet along the almon River, a bituminous seam at least 5 feet thick has been mined by the nglican Mission and the Hudson Bay Company (29). The first coal mining lease or the site was issued in 1923 and, by 1925, 50 tons of coal was being mined ach year (19). During the 1940's around 100 tons were produced annualy but ecently there has been no activity (7). On the south shore of Bylot Island irectly north of Pond Inlet, there are occurrences of bituminous coal (19).

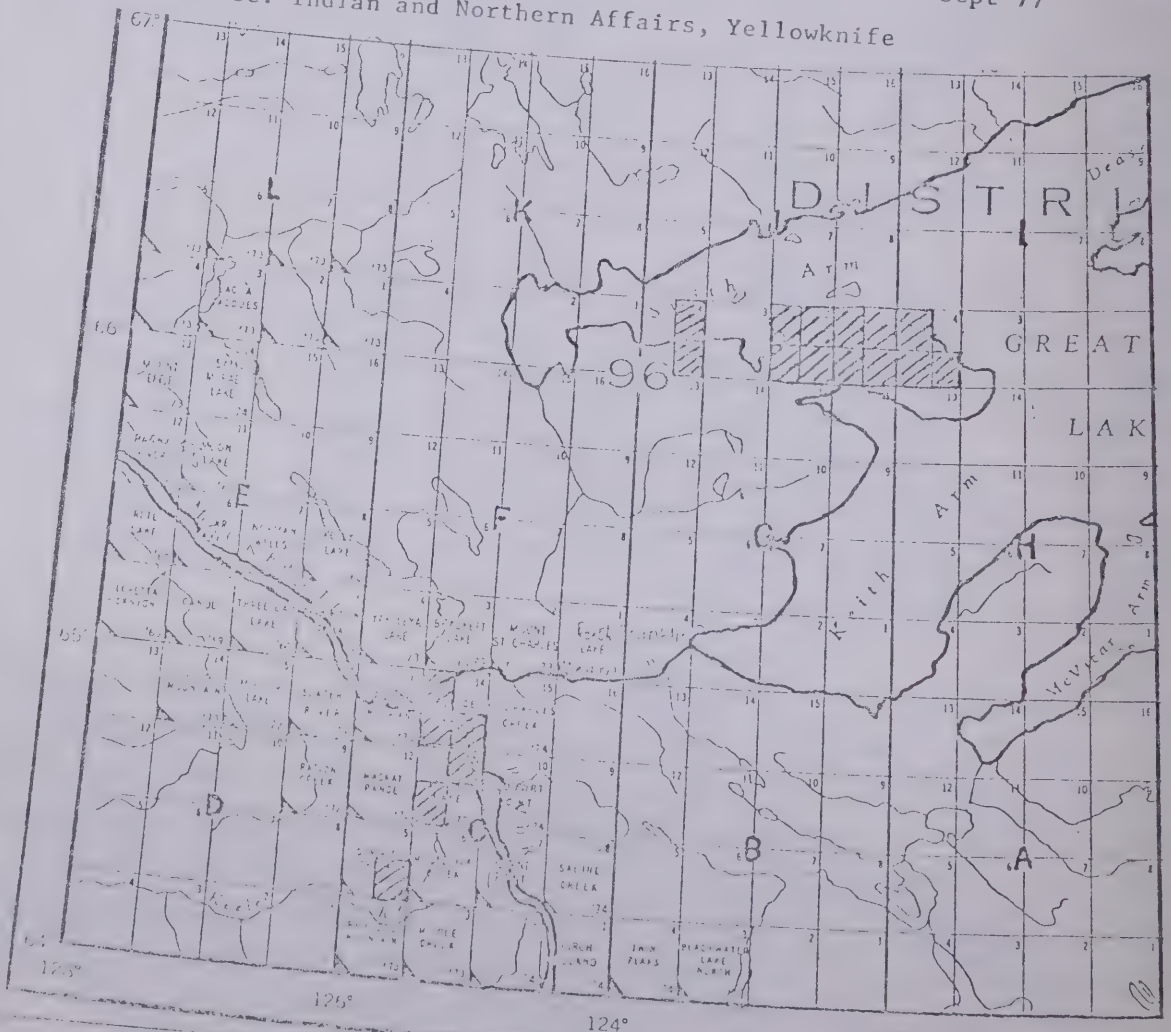
Northern Coal Regulations

Rules and regulations governing the aquisition, exploration, and production of coal in the Northwest Territories are included in the Territorial Coal Regulations, which form part of the Territorial Land Act, administered by the Department of Indian and Northern Affairs (32). These regulations cover coal exploration licences, coal mining leases, and coal mining permits. There are now 18 active coal exploration licences in the Northwest Territories as shown on Figure 7 . Each exploration licence covers one quarter of the area of the land shown on a mineral claim staking sheet.

The coal exploration licence is most appropriate for purposes of investigations over a large area. It is acquired by an application with a $10 fee and a bond of the amount required for the first year's expenditutures. Licences are in effect for 3 years if the yearly committments are fulfilled. Work committments are 5¢ per acre for the first year, 10¢ per acre for the second year, and 20¢ per acre for the third year. Excess expenditures in any one year can be carried over as part of the next year's requirements. Full reports of the work and expenditures must be made at the end of each year. Upon termination of the

No.	Licencee	Area	Date Issued
15	Luscar Ltd.	SWQ 96C-11	8 Dec 75
17	Manalta Coal Ltd.	NEQ 96C-11	24 Jan 76
20	Manalta Coal Ltd.	SEQ 96C-14	24 Jan 76
21	Manalta Coal Ltd.	SWQ 96C-14	24 Jan 76
22	Manalta Coal Ltd.	NWQ 96C-14	24 Jan 76
23	Phoenix Canada Oil Co. Ltd.	NWQ 96I-4	14 Sept 76
24	Phoenix Canada Oil Co. Ltd.	SWQ 96I-4	14 Sept 76
25	Phoenix Canada Oil Co. Ltd.	SEQ 96I-1	14 Sept 76
26	Phoenix Canada Oil Co. Ltd.	NEQ 96J-1	14 Sept 76
27	Phoenix Canada Oil Co. Ltd.	NWQ 96J-1	14 Sept 76
28	Phoenix Canada Oil Co. Ltd.	SWQ 96J-1	14 Sept 76
29	Phoenix Canada Oil Co. Ltd.	SEQ 96J-2	14 Sept 76
30	Phoenix Canada Oil Co. Ltd.	NEQ 96J-2	14 Sept 76
31	Phoenix Canada Oil Co. Ltd.	NWQ 96J-2	14 Sept 76
32	Phoenix Canada Oil Co. Ltd.	SWQ 96J-2	14 Sept 76
33	Lexco Testing Ltd.	SEQ 96C-5	7 Feb 77
34	Echo Bay Mines Ltd.	NEQ 96I-4	30 Aug 77
35	John Zigarlik	SEQ 96I-4	13 Sept 77

Source: Indian and Northern Affairs, Yellowknife



coal exploration licence, the licencee has sole right within 90 days to apply for a coal mining lease or permit.

Lease or permits must be staked with a rectangular shape, the length not exceeding four time the width. The maximum size for a lease is 640 acres and for a permit one acre. Leases have a term of 21 years and are renewable for an additional 21 years. A one dollar per acre annual rental is payable in advance. The royalty on coal mined from a lease is 10¢ per ton. Permits may be acquired for coal production by payment of a one dollar fee and a pre-production royalty of 25¢ per ton based on the amount of coal expected to be mined. Permits of one acre maximum size are for a one year term and are renewable.

In isolated portions of the Northwest Territories, Indians and Inuit who apply for permission to mine small quantities of coal may be granted permission to do so by an agent of the Territorial Lands or a member of the RCMP stationed in the area, free of charge, without being required to make application under the provisions of the regulations (32).

III-Community Coal Possibilities

Local coal deposits will be utilized for home heating in a northern community only when the advantages of a relatively low price, employment opportunities, and ready availability outweigh the possible disadvantages of other fuels such as heating oil or wood. Because of its cleanliness and ease of use, most northern residents will prefer to use heating oil as long as it is provided as part of the northern rental housing program or there are direct financial advantages.

The Northwest Territories communities that could consider coal for home heating are listed in Figure 8 along with the most likely coal source and its distance from the community. As local wood supplies have a comparable heating value to coal and appear to be available at comparable cost, the communities along the Mackenzie Valley within the treeline will not likely consider coal unless its delivered price is very low. The greatest possibilities for coal are in the Arctic communities where heating oil prices are likely to be higher and alternate energy sources are scarce. Aklavik, Paulatuk, and Pond Inlet seem to have the greatest potential for local coal developments.

Figure 8

NWT Communities With Nearby Coal Sources

Community	1978 Population*	Most Likely Coal Source	Distance to Community
Aklavik	797	Moose Channel	45 miles
Fort Franklin	463	Scented Grass Hills	80
Fort Liard	325	Liard River	5
Fort McPherson	790	Peel Plateau	105
Fort Norman	290	Little Bear River	20
Fort Providence	566	Great Slave Plain	?
Fort Simpson	1083	Great Slave Plain	?
Inuvik	3065	Moose Channel	70
Norman Wells	330	Little Bear River	55
North Star Harbour	20	Franklin Bay	35
Paulatuk	160	Darnley Bay	20
Pond Inlet	620	Tuluken	20
Resolute Bay	181	Intrepid Bay	25
Sachs Harbour	173	Alexandre Milne Point	150
Tuktoyaktuk	746	Moose Channel	90

* Source: Dept of Local Government, Govt of the NWT

Where all, or nearly all, of the homes in a community are under the Government of the Northwest Territories' Northern Rental Housing Program, a switchover to coal could be initiated on a community wide basis providing there was community agreeance, financial advantages, and employment opportunities. Presumably the same funds used to purchase heating oil could be spent in the community to mine and deliver the coal.

A few places, such as Inuvik and Tuktoyaktuk, have the possibility of a natural gas supply that could be utilized for home heating. Many Norman Wells homes are already connected to gas lines.

Home Heating With Coal

Coal and wood are comparable for home heating and generally stoves and furnaces can be used interchangeably for either fuel. In recent years there has been a considerable increase in the use of wood for home heating throughout North America. This situation has developed because of the rapid jumps in heating oil prices and the introduction of the environmental ethic for conserving energy and the use of renewable resources. There appears to be a comparable increase in the use of wood for home heating in the North. For example, the permits for fuel wood gathering have dramatically increased in the Fort Smith Lands and Forest District over the past few years going from 214 cords in 1973/74, to 311 cords in 1974/75, and to 1045 cords in 1975/76 (37).

There are several modern stoves and furnaces available that can efficiently burn coal. Some of these are illustrated in Figure 9 . The new multi-fuel forced air furnaces are a novel development with potential application in northern homes considering the use of coal. These furnaces burn oil, coal, and wood. The oil fired section is a backup to either a coal or a wood burning section with the oil section turning on automatically when the other section burns down and cools off. Thus, the advantages of low cost fuels can be combined with the convenience and dependability of an oil furnace.

Larger community buildings such as schools and nursing stations can be effectively heated by coal using fully automated stoking furnace units.

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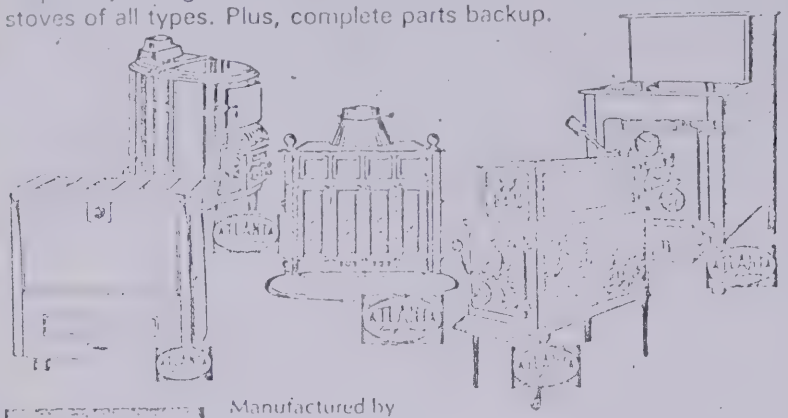

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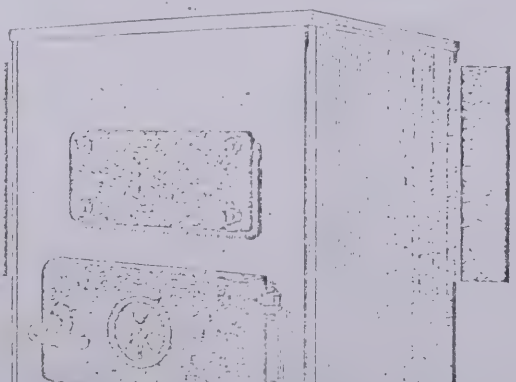

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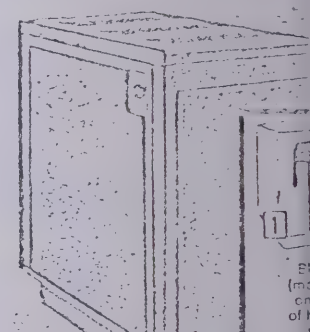

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firebox. 19¼x10½x24½ inches deep. Cast-iro
door, ash door and built-in grate.
DRAFT CONTROL: Non-electric thermostat c
closes damper automatically to control fire.
CONSTR: Walnut brown enameled metal cab
sures 32x19x33 inches high. Gold-color me
Right end doors for feeding fuel, removing as
VENTING: Vents upward from rear using elb
ORDER INFO: Installation, Chimney Notes b
42 K 84065N—Shpg. wt. 235 pounds.....

Same as above, but for burning coal or w
reinforced firebox and movable grates.
42 K 84068N—Shipping weight 260 lbs. ...

Community Heating Requirements

It is difficult to accurately estimate the total heating requirements for northern communities as the amount of energy required to heat a northern home varies greatly with the its size, degree of insulation, and location. There are also heating requirements for community buildings such as schools and stores which have to be included.

Previous studies indicate that an average home in the Northwest Territories requires about 1400 gallons of heating oil each year (35, 42, 44). With a net heating value of 0.105 million btu per gallon, this amount of heating oil would produce 147 million btu of thermal energy. The coal equivalent of this at a net heating value of 14 million btu per ton is 10.5 tons per home per year.

The number and size of institutional and commercial buildings requiring heating vary from community to community. Other research indicates that there is an average heat requirement for these buildings that is equivalent to that required for home heating in a community. Thus for total community heating requirements the thermal energy per house is around 2800 gallons of heating oil or 21 tons of coal per year.

The total community heating requirements have been calculated for Aklavik, Paulatuk, and Pond Inlet as representative communities that are most likely to utilize local coal deposits in the future. The data for these communities is presented in Figure 10. The total community heating requirements are based on the actual volumes of heating oil consumed during 1977 for Paulatuk and Pond Inlet. The amount is estimated for Aklavik. If coal replaced all the heating oil now being used, there would be an annual coal requirement of 2850 tons at Aklavik, 310 tons at Paulatuk, and 3915 tons at Pond Inlet. The actual coal requirement would probably be lower as it is unlikely that all of the heating oil requirements could be displaced by coal. Accordingly, the probable annual community requirements for coal are shown in Figure 10along with the daily production to meet this requirement if the coal mines operate for 200 days per year and for 100 days per year. These calculations provide a rough estimate of the volumes of coal that would have to be produced from a local mine to meet the community's requirements.

Figure 10

Estimation of Community Coal Requirements

	Aklavik	Paulatuk	Pond Inlet
Population - March 1978	797	160	620
Heating Oil Delivered 1977, gallons (Govt NWT Supply and Service)	380,000(est)	41,000	522,000
Per capita heating oil consumption	477	256	842
Total Heat Supply, million btu (at 0.105 million btu/gallon)	39,900	4,300	54,800
Coal equivalent, tons (at 14 million btu/ton)	2,850	310	3,915
Probable Annual Community Requirement, tons	2,400	300	3,600
Daily Production - 200 days per year	12	1.5	18
- 100 days per year	24	3	36

Specialty Local Coal Requirements

For the present and forseeable future the local coal deposits in the Northwest Territories, if developed at all, will be used to heat homes and community buildings. Should the price of petroleum products increase at a much greater rate than the price for coal, there is a remote possibility that larger communities using diesel electric generation such as Inuvik and Frobisher Bay could switch to coal fired thermal electric generation. It appears that the minimum practical size for thermal electric production is in the order of 10 megawats and is not fully effective until there is a demand for around 25 megawatts. None of the northern communities now on diesel power are large enough to support this kind of development.

There is a specialty use for coal in connection with the offshore petroleum operations in the Beaufort Sea where coal dust is spread on the ice around wintering ships to accelerate thawing and allow the ships to breakout of the ice earlier. On the 1977 sealift for Canadian Marine Drilling Ltd., 375 tons of coal were brought in for ice dusting. In the future this requirement could be filled by working the nearby mine at Paulatuk.

Another specialty application for local coal deposits would be the production of coal briquets that would be sold to the northern communities for home heating, camp use, and outdoor barbequés. The coal briquets would be formed at the local mine site and would be packaged in plastic bags. They would be marketed throughout the North.

Local coal deposits could also be mined to support mining developments such as the Echo Bay Mines on Great Bear Lake and Nanisivik Mines on Baffin Island. Once the basic mining operations was in place to support the resource development, additional coal could be produced at low cost for local community use.

Several other local coal applications have been investigated but none of them appears practical at present. These include the gasification of coal either at the mine or just outside a community for heating gas distribution throughout the community; the generation of electricity at the mine for distribution by power lines to the local communities; and the local preparation of coal chemicals from the deposits.

IV-Local Coal Production

With the modern equipment that is now available to northern communities, local coal deposits in the Northwest Territories can be mined much more effectively than in the past. The actual methods of mining will be site specific but a few general possibilities are presented. There are two basic coal mining methods: strip mining and underground mining.

Strip mining is common where the coal seams are at or near the surface. However, with the permafrost conditions throughout the Northwest Territories, surface stripping is not expected to be practical unless the overburden materials are dry and can be easily moved. Under the present land use regulations it is anticipated that strip mining of coal seams would generally not be allowed since this method tends to be environmentally disruptive to the area involved.

A form of strip mining occurs when the coal seams are exposed along a canyon or cliff and the coal can be mined by scraping or augering it out horizontally. If there is much production, the accessible coal will be depleted and the equivalent of an underground mine will develop through the seams.

Underground mining methods will probably be utilized for most of the local coal mines for any reasonable production volumes. The actual mine entrance and adit layout will depend on the coal seam locations and thicknesses. For horizontal coal seams the layout should be level to facilitate the use of wheeled trucks to haul the coal. For vertical coal seams, consideration can be given to a hoisting arrangement to haul the raw coal out.

For the actual mining of the coal seams a wide range of equipment is available from regular construction equipment dealers. Some of the coal might be soft enough to use a regular back hoe digging unit. Other coals might be mined with a power auger or a "Ditch Witch" type of alligator cutting chain(See Fig 11). Standard underground mining methods using pneumatic or electric drill for blasting could be practical in some locations.

Figure 11

Powered Alligator Chain For Ripping Coal Seams

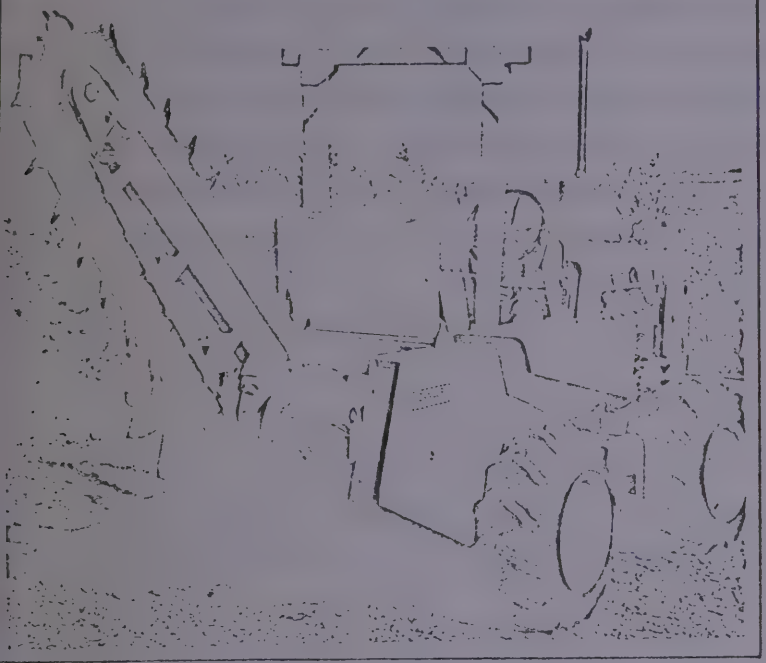
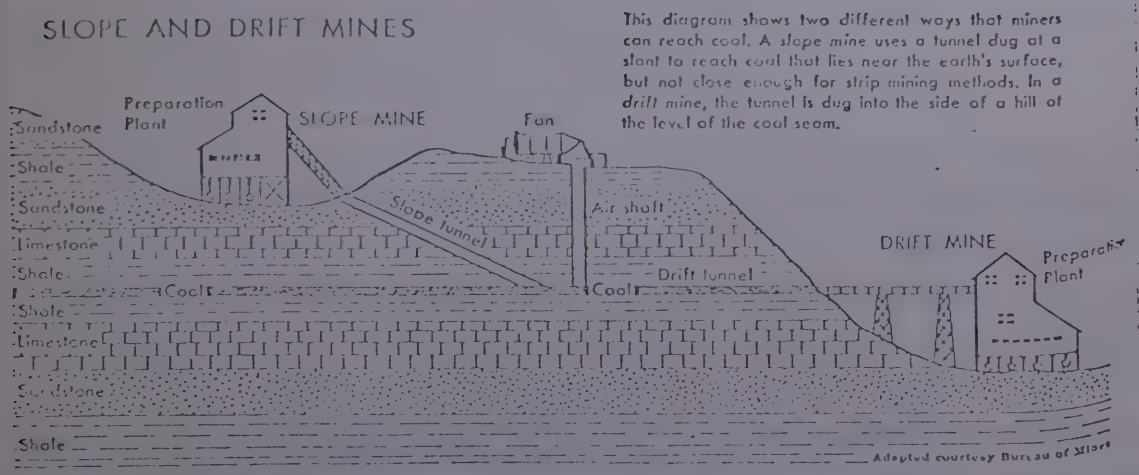


Figure 12

Underground Coal Mining Methods



Mine Safety

For any mining operations there must be an overall plan with full safety considerat designed in to maintain fresh air for miners, to prevent mine collapse, to eliminate poisonous gases, and to prevent explosions. For any underground mining activities, an experienced mining engineer should be consulted to insure that efficient and safe methods are used that suit the particular requirements of the coal seams. The Government mining safety inspectors should be fully involved in both the design and operation of the local coal mining facilities.

Coal Preparation

Once the coal is freed from the seams it has to be prepared for its end use applications. Coal preparation methods will vary with each mine site but there are some general considerations applicalbe to most coal mining situations.

Raw coal coming from the mine is screened with the proper sized coal going directly to a stockpile or loading chute. Larger coal pieces are separated from stones, shale, and dirt by a washer and hand picking. The larger coal pieces are then put through a crusher to obtain appropriate sizes. The prepared coal can be stored in piles on a flat well drained area or in bins.

For economy, every effort must be made to handle and ship the coal in bulk using dump trucks, large sleighs and wagons, or barges. For special situations the coal could be moved in 4 X 4 X plywood containers suitable for moving with a forklift. Regular coal sacks could be used for 75 to 100 pound loads. For possible retail sales, fine coal could be packaged in 25 to 40 pound plastic bags.

Mining Camp

A good mining camp complete with sleeping and eating facilities should be erected close to the mine operations. For most situations, a standard portable petroleum exploration camp would make an excellent facility. Equipment is needed for the provision of electricity, drinking water, and sewage removal. Equipment and vehicle repair facilities would also be an asset.

V-Local Coal Transport

Low cost transport of local coal to the northern communities is essential for any coal development program to be successful. Also the coal transport has to be integrated with both the mining project and home consumption needs. Each coal mine will have its own transportation solutions but there are a few northern mining basics for consideration.

Mechanical handling of the coal is necessary to keep labour costs down and to actually move the coal on a rigid schedule. Front end loaders and belt transporters can be used to load the coal. The coal should be handled as few time as possible to save expenses and to minimize breaking of the coal.

Ideally the coal would move directly from the mine to the point of consumption with only one loading. This situation might only be practical in the winter using trucks and ice roads. Probably the coal will have to be moved from storage at the mine site and stockpiled within the community for distribution as required to the homes and other buildings.

Where roads can be built, standard or big wheel dump trucks would be utilized. For operating economics, the largest possible size trucks would be operated. For rough overland travel, heavy duty sleighs pulled by tractors could be used. For summer marine situations, barges are the most suitable especially if they can be rigged for easy loading and unloading.

An analysis of the coal market and the tonnages to be moved will dictate the actual transport process and unit sizes. Using the three high possibility communities from Figure and their probable annual coal requirements, the following transport scenarios have been developed to illustrate alternate methods:

Aklavik :annual coal requirement 2400 tons to be transported 45 miles from the Coal Mine Lake mine.
:utilize a 50 ton barge and tug making 48 trips over 16 weeks from July to October.
:Barge makes 3 trips per week, one day each way, with one day a week free for crew rest, repairs, or catchup time.

Paulatuk :annual coal requirement of 310 tons to be transported 20 miles from the mine site just east of the Hornaday River delta.
:utilize a 10 ton sleigh or big wheel wagon pulled by a cat over the ice of Darnley Bay for 10 weeks from January to April.
:unit to make 3 trips a week, 1 day each way, with a free day each week for crew rest, repairs, or catchup time.

Pond Inlet :annual coal requirement of 3600 tons per year to be transported 20 miles from Tuluken along the Salmon River.
:assume a tote road can be built to Pond Inlet winter travel.
:utilize two big wheel trucks each carrying a 10 ton load and making 180 trips per year.
:each truck could make 2 trips a day for 90 days or 1 trip a day for 180 days.

Figure 13

Possible Coal Transport To Aklavik Scale 1:500,000

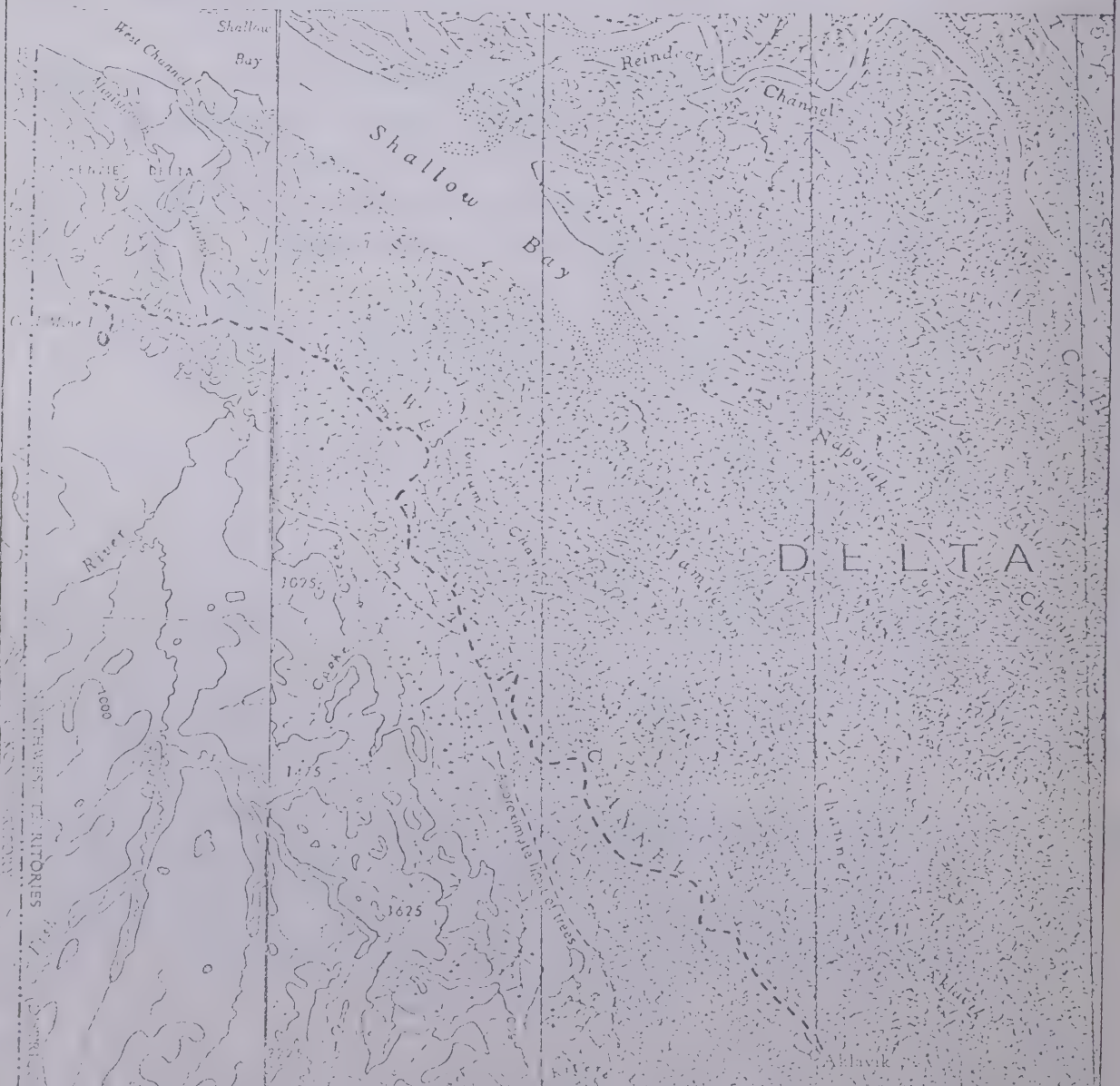


Figure 14

Possible Coal Transport To Paulatuk Scale 1:500,000

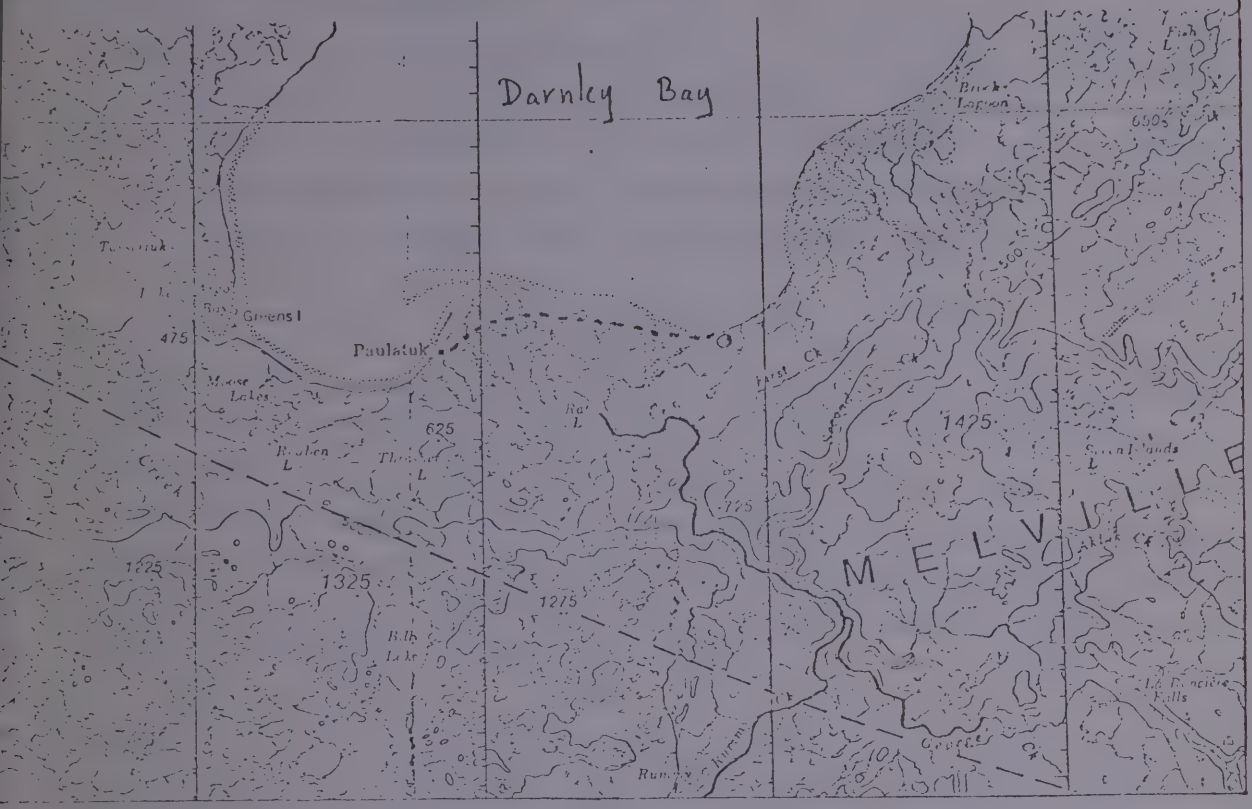
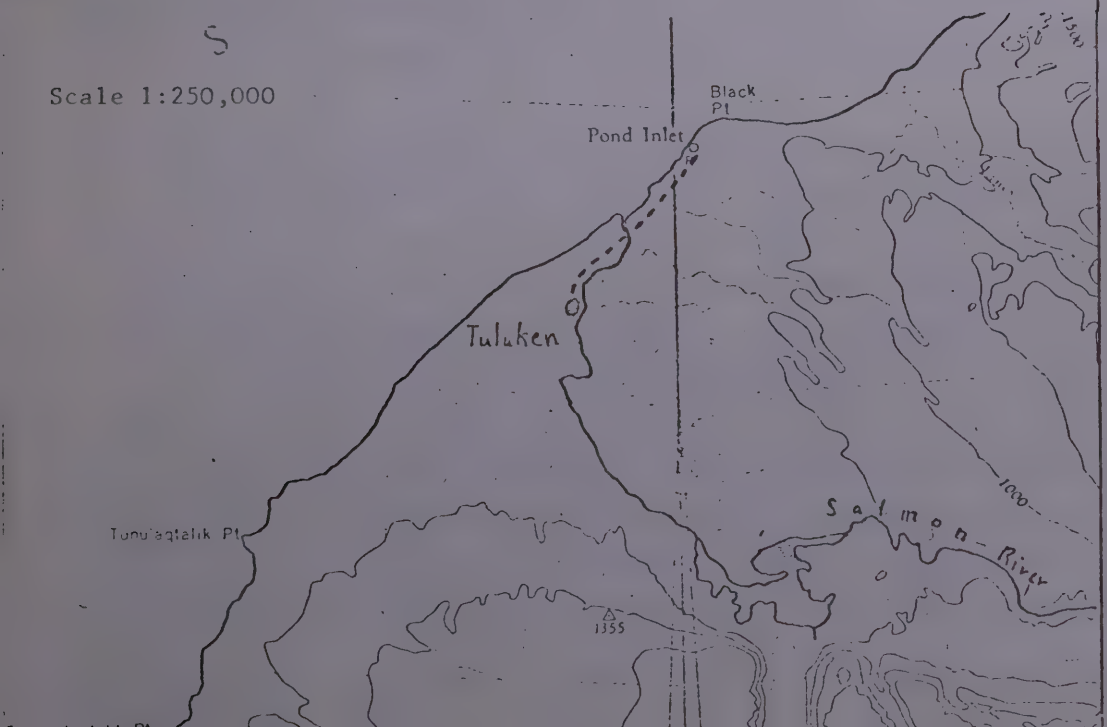


Figure 15

Possible Coal Transport To Pond Inlet Scale 1: 250,000



VI-Community Coal Utilization Economics

It is expected that coal will be utilized in the Northwest Territories communities only when there is a definite economic advantage over the cost of heating oil or wood. To establish the relative economics of home heating with coal, heating oil, and wood it is necessary to consider the net heat values of the fuels and determine their costs in the communities. Also, a convenience factor is introduced to cover the ease, cleanliness, and continuity of heating oil over coal and wood.

The figures used in this section to demonstrate the relative economics of coal, oil and wood are to be taken only as rough estimates. In actual practice the heat value of coal, oil, and wood can vary greatly as can the efficiency of home heating furnaces. An attempt has been made to take average values appropriate to the Northwest Territories situation so that the data will reflect the real northern energy situation. British thermal units (btu) are utilized as the common form of energy measurement.

Equivalent Costs of Coal and Heating Oil

The equivalent heating values of coal and heating oil are established in Figure 16 assuming that a coal furnace burns with 65% efficiency and an oil furnace with 62% efficiency. The net heat value of one ton of medium quality coal is equivalent to 150 gallons of heating oil. When a 50% convenience factor is included, the one ton of coal is equivalent to 100 gallons of heating oil.

The relationship between the cost of coal in dollars per ton and heating oil in cents per gallon is shown in Figure 17. Using the graph a direct equivalent value for coal and heating oil can be determined. For example, if coal is available at $75 per ton, its cost is directly equivalent to heating oil at 75¢ per gallon. Similarly, if heating oil is available at $1.00 per gallon, it is directly equivalent to coal at $100 per ton.

Thus, if coal was available at Aklavik for $75 per ton and heating oil costs $1.00 per gallon, there is a 25¢ per gallon disadvantage for using heating oil or a $25 per ton advantage for using coal. However, if the coal was available at $125 per ton , there would be a 25¢ per gallon advantage for heating oil and a $25 per ton disadvantage for coal.

Figure 16

Equivalent Heating Values of Coal, Oil, and Wood

	Total Heat Value million btu (a)	Conversion Efficiency (b)	Net Heat Value million btu (c)	Net Heat Equivalent (d)	Convenience Equivalent (e)
Coal	20 per ton	65%	13.0 per ton	1 ton	1 ton
Oil	0.14 per gal	62%	0.087 per gal	150 gal	100 gal
Wood	26 per cord	50%	13.0 per cord	1 cord	1 cord

(a) The total heat value for coal, oil, and wood varies greatly with the quality of the product. Average values are used here from the following range:

coal	15 to 25 million btu per ton
oil	0.13 to 0.15 million btu per gallon
wood	22 to 31 million btu per cord

(b) When a fuel is converted to heat in a furnace there is waste through chimney losses and incomplete combustion. The actual conversion efficiency of a stove or furnace varies greatly with the equipment and the installation. Average, but realizable, conversion efficiency values are used here.

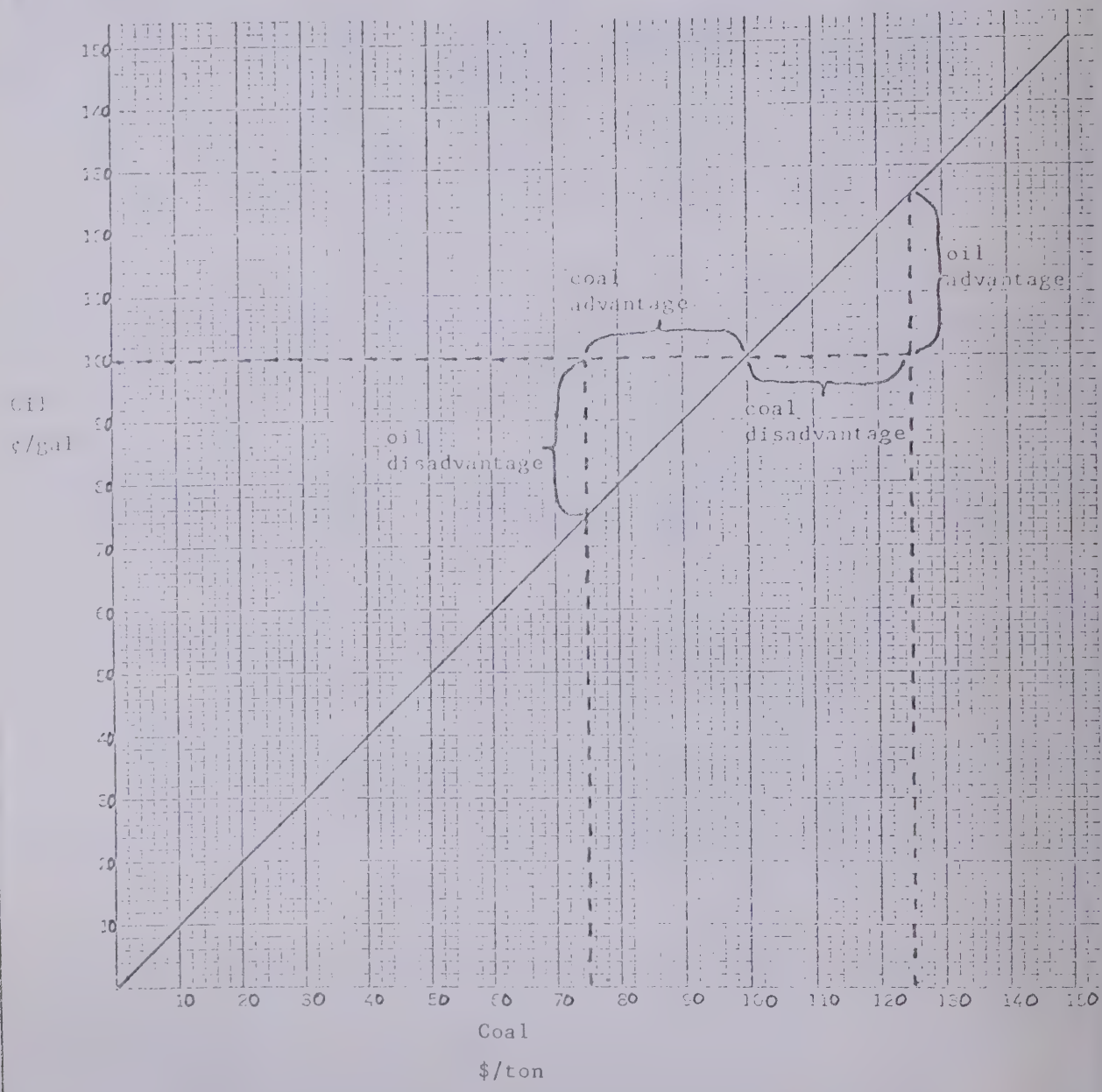
(c) Net heat value is the estimated amount of useful heat that will be realized by burning a fuel to heat a home.

(d) Net heat equivalent for one ton of coal is the number of gallons of oil or cords of wood needed to provide the same amount of useful heat.

(e) The convenience equivalent is an allowance to cover the ease, cleanliness, and continuity associated with oil heating as compared to the difficulties of mess, handling, and attention required with coal and wood. It is assumed that the conveience equivalent of oil is worth 50% more than coal or wood for the same heating values.

Figure 17

Equivalent Cost of Coal and Oil



-based on net heat and convenience equivalent of 1 ton coal to 100 gallons oil

-i.e. if coal is available at $75 per ton and oil is available at $1.00 per gallon, there is an advantage of up to $25 per ton for coal and a disadvantage of up to 25¢ per gallon for oil.

if coal is available at $125 per ton and oil is available at $1.00 per gallon there is an advantage of up to 25¢ per gallon for oil and a disadvantage of up to $25 per ton for coal.

uivalent Costs of Coal and Wood

e net heating value of a ton of coal and a cord of wood are comparable as own in Figure 16. The assumption is made that the efficiency of the coal rnace is 65% and the wood furnace is 50%. It is also assumed that the nvenience factor of using coal or wood is equivalent so that when heat lue and convenience are considered one ton of coal is comparable to one rd of wood.

cost comparisons between heating oil and wood are required, the graph in gure 17 can be utilized if wood in dollars per cord is substituted directly r coal in dollars per ton.

stimated Pricing For Community Coal

e actual cost of coal delivered to homes in a northern community will depend n many factors including the volume of coal required, the difficulties of ining, and the distance between the mine and the community. To establish rough coal price for estimation purposes the costs of delivering coal to klavik are calculated. Presumably comparable prices will apply for other orthern communities.

he costs estimates for coal delived to homes in Aklavik is $100 per ton s shown in Figure 18. This figure appears realistic considering the ost of labour and the need for a high degree of operating equipment. The rice could be lower if there were higher production volumes or capital inancing assistance.

or comparison, sub-bituminous coal from Drumheller is available in Calgary t $38.50 per ton with a $10 per ton local delivery charge.

Figure 18

Cost Estimate For Aklavik Coal

Coal to be mined at the Coal Mine Lake property on Moose Channel approximately 45 miles from Aklavik by barge.

Annual mine production will be 2400 tons. An average of 12 tons will be produced per day for 200 operating days in the year. Each operating day will have six actual producing hours at the rate of 2 tons per hour.

Cost Per Hour	Labour 5 men at 8.33 hour ($50 day per man for 6 hours day)	$42
	Cost of equipment for mining and loading (drills, wagons, cat, & loaders)	58
	Total costs per hour	100
	Overhead allowance at 50% (camp, utilities, supplies, profit)	50
	Total hourly cost for 2 tons coal	150
Cost Per Ton	Production cost per ton from above	$75
	Barging to Aklavik including unloading ($750 per trip with 50 ton load)	15
	Local delivery to homes in Aklavik (includes truck loading)	10
	Total delivered cost per ton	100

Figure 19

Cost Estimates For Northern Cordwood

Cordwood to be cut in stove lengths at small camps with coordinated delivery to homes in a northern community by truck. Assumes 2 men can cut and stack 2 cords of wood per day.

Cutting Costs	2 men at $6 hour for 8 hours	$96
	25% overhead for supplies, fuel, etc.	24
	Total cost for 2 cords	120
Cost per Cord	Cutting costs from above	$60
	Truck delivery based on average haul distance of 10 miles	30
	Total delivered cost per cord	90

Estimated Pricing For Community Cordwood

Considerable quantities of wood are used for home heating in many of the Mackenzie Valley communities. The reported values for this wood vary from $25 to $100 per cord.

Cost estimates for cutting and delivering northern cordwood at $90 per cord are shown in Figure 19. This figure compares with current cordwood prices in Calgary where Spruce wood can be delivered for $70 per cord and Birch wood can be delivered for $135 per cord.

When considering the economic and convenience aspects of heating oil over wood for home heating, one cord of wood is equivalent to 100 gallons of heating oil. Thus, if oil costs $1.00 per gallon, it would be equivalent toWood at $100 per cord. As long as wood costs less than $100 per cord, it would be advantageous to use wood.

Heating Oil Prices

The price of heating oil has increased dramatically throughout the Northwest Territories in recent years. For example, heating oil in Aklavik in 1966 was reported at 37.6 ¢ per gallon (6) but in 1977 was listed at 97.0¢ per gallon (40) or 2½ times higher.

Petroleum prices in the North are dictated by national and international pressures even though recent exploration has found vast quantities of northern petroleum reserves and there is a refinery at Norman Wells. The present heating oil prices and equivalent prices for local coal are shown in Figure 20 for NWT communities with nearby coal mines. If local coal is available at $100 per ton, only Aklavik, Inuvik, and Resolute would be very interested in using coal.

However, with the world price of crude oil expected to double again in the next 5 to 10 years, it can be expected that the price for heating oil in the North will double for all NWT communities. When the price of 100 gallons of heating oil gets to be higher than the cost of one ton of local coal, there should be a definite interest in opening up local coal deposits.

Figure 20

Community Heating Oil Prices and Coal Equivalent

Community	Heating Oil Price* cents per gal	Equivalent Price of Coal dollars per ton
Aklavik	97¢	$97
Fort Franklin	69	69
Fort Liard	68	68
Fort McPherson	60	60
Fort Norman	56	56
Fort Providence	73	73
Fort Simpson	62	62
Inuvik	98	98
Norman Wells	42	42
Paulatuk	86	86
Pond Inlet	80	80
Resolute Bay	181	181
Sachs Harbour	81	81
Tuktoyaktuk	67	67

*source: Govt of NWT Survey of Petroleum Product Prices as of 1 Dec 1977
Appendix B, NWT Legislative Assembly Debates, January 1978

VII-Community Coal Development Program

Before any local coal deposits can be considered for production, additional data is required for each community situation. A suggested outline for a community coal development program is shown in Figure 21. A local coal deposit evaluation would establish the best coal mine site for the community. Through a production evaluation process the best mining methods and estimated operating costs would be obtained. Finally, a market development process would establish community economic advantages for using coal and prepare local residents for its use.

Figure 21

Processes For a Community Coal Development Program

I -Deposit Evaluation	1. Surface observation of known and possible coal occurrences 2. Test drilling of best occurrences for a rough estimate of coal depth and extent 3. Establish coal quality through collection of samples and laboratory analysis 4. Determine suitability of coal seams for mining 5. Consider the distance and accessibility for economical coal transport to the community
II -Production Evaluation	1. Delineation drilling to accurately determine the size and location of the coal seams 2. Engineering plan for mine layout and equipment needed for mining 3. Determination of best coal transportation methods 4. Program for staff training to operate the mine 5. Detailed cost on overall operations
III-Market Development	1. Establish the economic advantage of coal over heating oil or wood 2. Determine community benefits such as employment and funds saved for other projects 3. Program for changing home furnaces to burn coal 4. Training program for operation of coal furnaces 5. Community schedule for the introduction of coal

Rough cost estimates for Community Coal Development Programs have been prepared for Aklavik, Paulatuk, and Pond Inlet as shown in Figure 22. The main difference between the communities is the higher costs of transportation to Paulatuk and Pond Inlet. These costs estimates are for specialists visits, test drilling, and reports. There is no provision for the purchase of equipment or any mining. Comparable evaluation costs should be considered for other community coal development possibilities.

Figure 22

Community Coal Development Program Cost Estimates

	Aklavik	Paulatuk	Pond Inlet
I-Deposit Evaluation			
1. Surface observations	5,000	7,500	10,000
2. Test drilling	20,000	25,000	30,000
3. Coal quality	1,500	2,000	2,000
4. Mining suitability	5,000	7,500	7,500
5. Community accessibility	1,500	1,500	1,500
Total	33,000	43,500	51,000
II-Production Evaluation			
1. Delineation drilling	25,000	30,000	50,000
2. Engineering plan	15,000	15,000	15,000
3. Transport methods	1,500	1,500	1,500
4. Staff training program	5,000	5,000	5,000
5. Operation costing	5,000	5,000	5,000
Total	51,500	56,500	76,500
III-Market Development			
1. Economic advantages	1,000	1,000	1,500
2. Community benefits	1,000	1,000	1,000
3. Furnace changeover program	1,500	1,500	1,500
4. Community education program	2,500	2,500	3,000
5. Introduction schedule	500	500	500
Total	6,500	6,500	7,500
IV-Total Development Program	91,000	106,500	135,000

Due to the relatively high development costs for opening up a local coal mine and anticipated resistance from residents to switching from heating oil to coal, it is suggested that one NWT community be selected for an overall evaluation and concept demonstration of community coal utilization. The process of evaluation, mine opening, and community introduction could take from 2 to 5 years depending on the project urgency. However, as the heating oil prices are escalating rapidily, a community test project should be initiated as soon as possible so that there will be practical northern experience on alternate energy utilization before rapid changes are forced on all Northwest Territories communities.

Some development time could possibly be saved if small coal mines elsewhere were visited to pick up the modern techniques that are applicable to low voulume mines producing only 1 to 10 tons of coal per day. At present there are very few "small" coal mines operating in the world as most have either become bigger to survive or have gone out of business. There are some independent small coal operators in the Appalachian region of Kentucky and Ohio which could be visited for concepts on the operation of a small northern coal mine.

Another aspect of community coal utilization and heating oil conservation would be the encouragement of small stoves for kitchens or living rooms in northern homes. A small stove provides a warm, friendly heat source as well as functional heat for warming water or kitchen pans. These stoves, burning either coal or wood, can supply considerable useful heat and save on heating oil consumption. They are becoming quite popular in southern homes as part of the environmental protection and energy conservation movement. They are even more practical for a northern home and, not so long ago, almost every northern home had a small cookstove or parlor stove for supplementary heating. As a means to cut down on the oil heating bills for northern rental housing and for private homes, it would be appropriate for the government to encourage the use of small stoves again.

Long range energy planning considerations should also be given to evaluate the Northwest Territories coal resources from a northern resident viewpoint. Points to be covered would include:

-Northerner ownership of coal leases
-Northerner employment in coal developments
-environmental considerations for northern coal developments
-delineation of all know coal occurrences in the Northwest Territories
-evaluation of coal quality for all known coal occurrences
-coal production for electrical generation
-coal production for export from the Northwest Territories
-coal production for gasification or chemical processing
-coal production for northern metalurgical processing

The coal resources of the Northwest Territories could become the most valuable northern asset. Every effort should be made to understand this resource and to manage it wisely.

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